



U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Cooling Water Systems

AP1000 Technology Section 6.2

Learning Objectives:

- 1. State the purpose of the following AP1000 Cooling Water Systems.**
 - a. Component Cooling Water System (CCS)**
 - b. Service Water System (SWS)**
 - c. Spent Fuel Cooling System**
 - d. Turbine Building Closed Cooling Water System**
 - e. Condenser Circulating Water System**

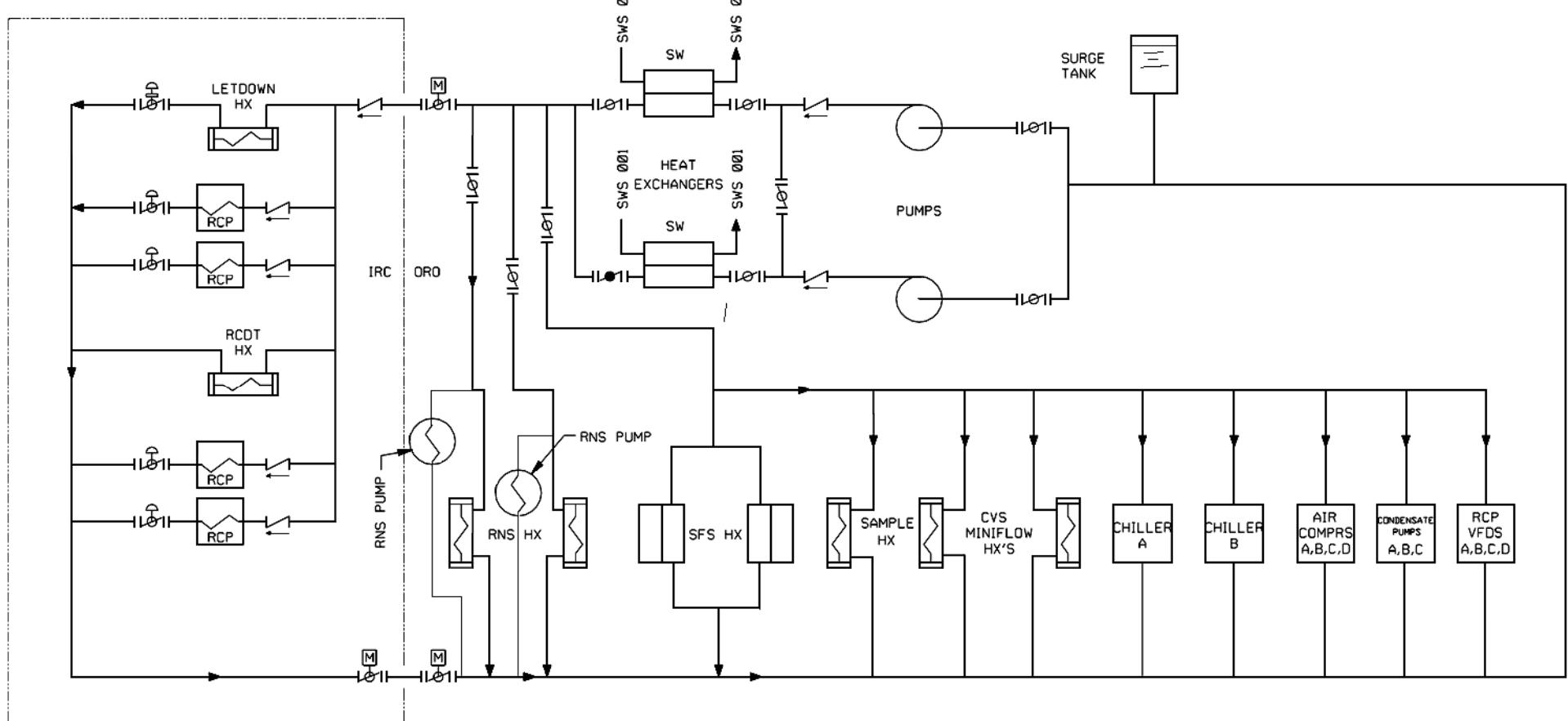
- 2. Describe the major differences between the AP1000 and current operating Westinghouse plants Cooling Water Systems.**



Component Cooling Water System (CCS)

Purpose

- CCS is a non-safety, closed loop system that transfers heat from various plant components to the service water system (SWS) during normal operation.
- It removes core decay heat and sensible heat for normal reactor shutdown and cooldown.
- It provides a barrier to the release of radioactivity between the plant components being cooled that handle radioactive fluid and the environment.
- It provides a barrier against leakage of SWS fluid into primary containment and reactor systems.



CCS Normal Operations

- Cools primary plant equipment needed for full-power operation
- Cools plant equipment used to attain cold shutdown conditions
 - RCPs, RNS heat exchangers and pumps, CVCS pump coolers
- Cools SFS heat exchanger

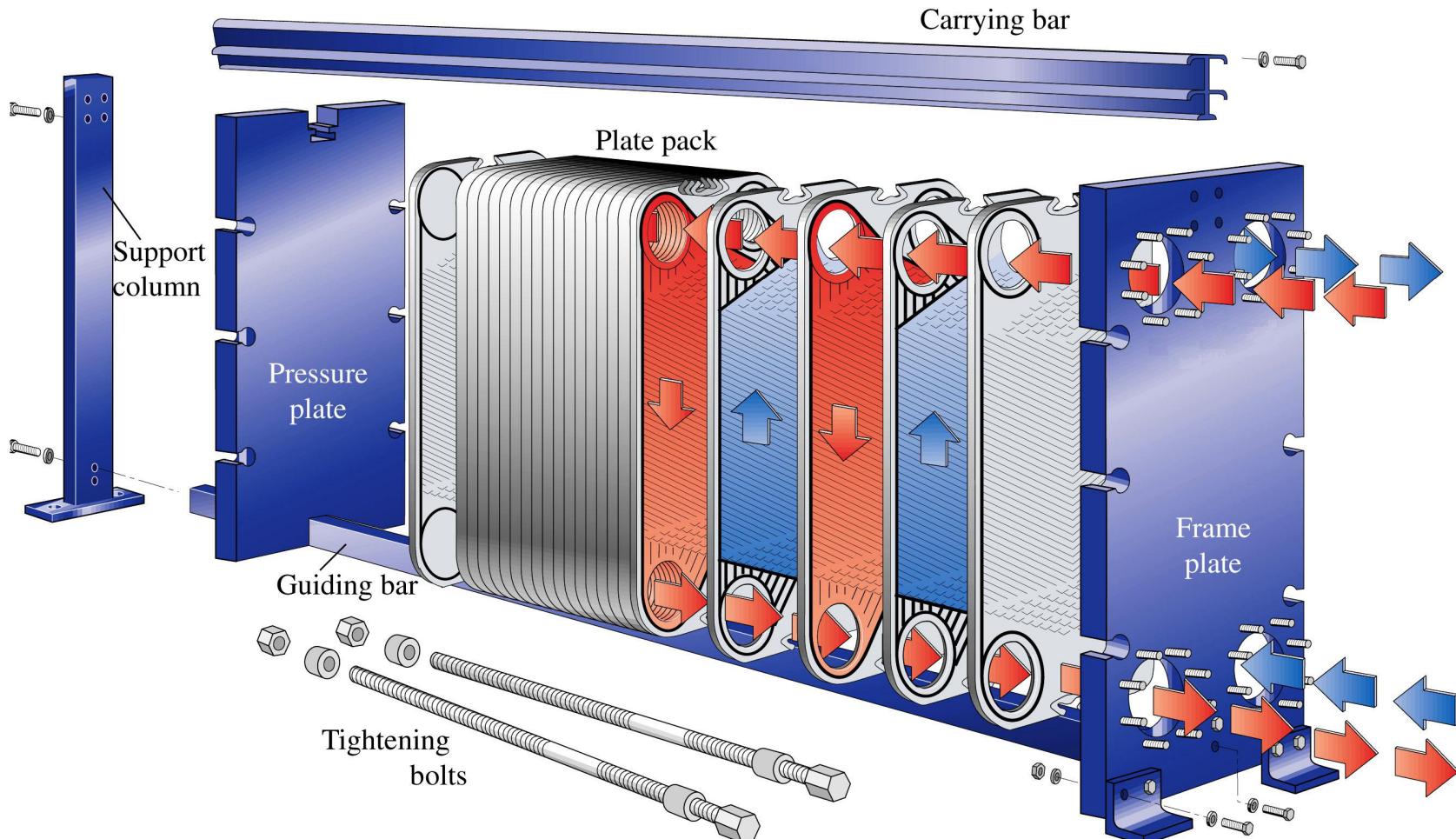
Reactor Coolant Pumps

- Primary heat load during normal plant operations
 - Canned motor pumps are less efficient – produce a much higher heat load on CCS
- RCPs can accept 110°F for limited periods of time
- Auto isolation of CCS to containment on high RCP bearing water temp. reactor & RCP trip
 - Protects CCS from potential leakage through an external heat exchanger tube rupture

CCS Heat Exchanger

- Plate type heat exchangers
 - Initial cost ~70% less than shell and tube HX
 - Plate HX occupies half the space of shell and tube HX
 - Plate HX's capacity can quickly be changed by adding or removing plates
 - Pressure drop across a plate HX is generally lower permitting use of smaller pumps
- CCS water is maintained at a higher pressure than the SWS to prevent leakage

Plate Type Heat Exchanger



Loss of CCS

- Loss of normal AC power
 - CCS pumps are automatically loaded on the standby diesel (non-safety related)

- Loss of Component Cooling Water
 - Fire Protection System can provide the source of cooling water for a RNS heat exchanger and a RNS pump



Service Water System

Purpose

- Supplies cooling water to remove heat from the nonsafety-related CCS heat exchangers.

SWS Pumps

- 2 Vertical, centrifugal, constant speed, electric motor-driven pumps

- Powered from the normal ac power system and are backed by the standby DG power



SWS Normal Operations

- Provides cooling water at a max temp of 93.5°F to the CCS exchanger in service.

- One SWS pump normally in service.

- The standby SWS pump auto starts if the operating pump should fail.

Cooling Tower

- Standard AP1000 design uses a counterflow, induced draft tower divided into two cells
- Each cell utilizes one fan
- Depending on the plant site chosen may or may not utilize this arrangement



Spent Fuel Cooling System

Purpose

- Non-safety-related system
- Designed to remove decay heat from the fuel pool
- Circulates water through filters & demineralizers to maintain fuel pool water purity
- The safety-related function of cooling and shielding the fuel is performed by the water in the pool.

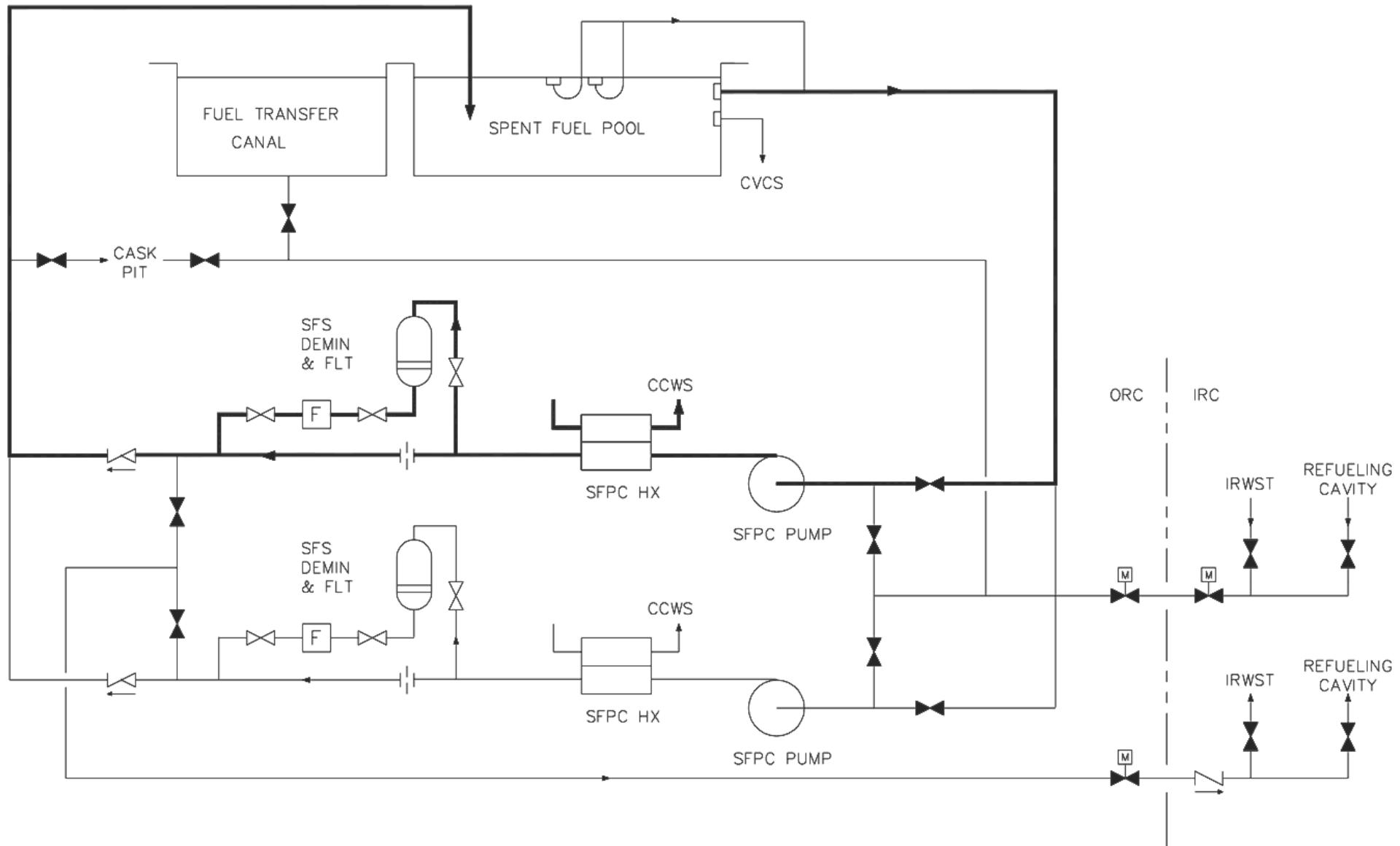


Figure 6.2-2

Refueling Ops

- For fuel shuffling (partial core off-load), both SFP heat exchangers are used to maintain the SFP water temp < 120°F.

- With a full core off-load and 10 years accumulation of spent fuel in the pool, both SFP heat exchangers and one RNS heat exchanger are used to maintain the SFP water temp < 120°F.

Loss of Power

- The SFP cooling system pumps can be manually loaded on the onsite standby DGs.

- SFP makeup for long term station blackout can be provided through seismically qualified safety-related makeup connections from the passive containment cooling system .



Turbine Building Closed Cooling Water System



Purpose

- Provides chemically treated, demineralized cooling water for the removal of heat from nonsafety-related heat exchangers in the turbine building.

Description

- Two 100-percent capacity pumps, three 50-percent capacity heat exchangers (connected in parallel), and one surge tank.

- Heat is removed from the heat exchangers by the circulating water system.



Condenser Circulating Water System

Purpose

Supplies cooling water to remove heat from:

- the main condensers,
- the turbine building closed cooling water system (TCS) heat exchangers, and
- the condenser vacuum pump seal water heat exchangers

Description

- Three 33-1/3-percent-capacity circulating water pumps, one hyperbolic natural draft cooling tower, and associated piping, valves, and instrumentation.

- Depending on plant site selection a cooling tower may or may not be utilized.

Questions?





Which one of the following is the Ultimate Heat Sink for the AP1000?

- a) Service Water System
- b) Lake, River, Ocean, or other body of water used by the Condenser Circulating Water System
- c) Component Cooling Water System
- d) The surrounding environment (via passive containment cooling system)



**Which one of the following is the largest heat load
on the CCS during normal power operations?**

- a) Spent Fuel Cooling Heat Exchanger

- b) Reactor Coolant Pump Motors

- c) Main Feedwater Pump Motors

- d) Containment Coolers



With a full core off-load and 10 years accumulation of spent fuel in the pool, which one of the following describes the required cooling arrangement for the SFP?

- a) One SFP heat exchanger and one RNS heat exchanger are required.**

- b) One SFP heat exchanger and two RNS heat exchangers are required.**

- c) Both SFP heat exchangers and one RNS heat exchanger are required.**

- a) One SFP heat exchanger is required.**